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Development of the Charge-Exchange Oslo Method and Application Towards Constraining Reaction Rates for Nucleosynthesis of Cosmochronometer ^{92}Nb

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Charge-Exchange (CE) reactions are an important tool for studying the spin-isopin response of nuclei. They can be utilized to obtain information about interactions mediated by the weak nuclear force, such as β and electron capture decay. Using the proportionality between Gamow-Teller strength (B(GT)) and the CE differential cross section, B(GT) distributions can be extracted indirectly. Since CE reactions are not limited to a narrow Q value window, they provide information that is complementary to information obtained from β and electron capture decay. Such data are necessary for constraining reaction rates that happen in dense and hot astrophysical environments. In the near future, it is planned to combine measurements in which GT strengths are extracted with γ-decay measurements, utilizing the Oslo method to extract level densities and γ-ray strength functions, which are also important for constraining astrophysical reaction rates. It is proposed to measure the ^{92}Zr(^{3}He, t + γ) reactions at 420 MeV in RCNP to develop the Charge-Exchange Oslo (CE-Oslo) method and to extract reaction rates for the nucleosynthesis of cosmochronometer ^{92}Nb. This high precision study will lay a solid foundation for using the CE-Oslo method in future (p, n + γ) experiments in inverse kinematics with rare isotopes and make it possible to simultaneously extract nuclear level densities (NLDs), γ-ray strength functions (γSFs), β-decay strengths and (β-delayed) neutron decay probabilities (P_{n}) on neutron-rich unstable nuclei, which are important for several nucleosynthesis processes, including the r, i, γ, and ν processes. The high resolution available for (^{3}He, t) experiments at RCNP will make it possible to extract level densities in two independent manners: by using the Oslo technique and by using the fine-structure analysis. From the measurement on ^{92}Zr, it will be possible to extract level densities and γ-ray strength functions which are relevant for the γ-process in type Ia supernovae and Gamow-Teller strength distributions of relevance for the ν-process in core-collapse supernovae. These astrophysical phenomena are the possible sites for the production of long-lived ^{92}Nb, which can serve as a cosmochronometer. As an initial test, the CE-Oslo method is being tested on (t, ^{3}He + γ) data taken previously with the S800 spectrometer in coincidence with the GRETINA γ-ray detector at FRIB. Preliminary results of the analysis will be shown at the conference.

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References:

1. R. Zegers, Research Proposal, Submitted to the B-PAC at RCNP (2020)
2. T. Hayakawa et al., Ap.J.Lett. 779, L9 (2013)
3. A. Spyrou et al., Phys. Rev. Lett. 113, 232502 (2014)
4. B. Gao et al., Phys. Rev. C 101, 014308 (2020)

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